Development of Community Power Corporation's Small Modular Biomass Power system

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In December 1999 Community Power Corporation initiated an effort to design and develop a small modular biomass power (SMB) system for deployment in rural electrification markets. Shell Renewables partnered with Community Power on this project and together they identified a rural village on the island of Panay in the Philippines for initial field deployment. During 2000 the system was designed, fabricated, and underwent performance testing. In March/April 2001 the field prototype unit was deployed in the village of Aliminos in Aklan Province where it provided power to 120 households while continuing to accumulate operating performance data.

Design features / objectives

The SMB was designed to provide 12.5 kW on a sustained basis using a fixed bed downdraft gasifier as the primary biomass conversion device. The gasifier incorporates features that reduce tars to less than 100 ppm in the raw gas. Because of their abundant availability in the Philippines, coconut shells are the primary feed for the system. Tar and particulates are removed from the raw gas stream with a dry clean up system comprised of a tar trap and two filters in series. The tar trap is a fixed bed of charcoal designed to reject some of the heat from the raw gas stream before it percolates upward through the bed. The primary filter is a simple polyester bag filter followed by a pleated cellulose cartridge safety filter. There are two sets of these filters configured in a parallel arrangement so that one may be cleaned while the other remains in service. A cooler precedes the filters and reduces the gas temperature to levels acceptable for the filter materials. Heat in the gas stream is also managed to maintain the temperature above the dew point from the exit of the filters to the intake manifold of the engine. A commercial 3.9-liter spark ignition engine is coupled to a 22 kW generator via a set of pulleys and belts.

Performance characteristics

The SMB has been subjected to laboratory endurance testing where the gasifier, gas clean up train, engine, and generator performance has been evaluated. Brief results are listed below:

?? Gasifier temperatures and flame front stability are able to remain at steady state conditions via automatic control of secondary char air addition and charcoal removal rates. Gas composition and LHV remain relatively constant during operation at varying load profiles with the LHV at 5.3-5.4 MJ/M^3. Pressure drop across the gasifier also remains stable at 1.7-2.0 kPa at maximum load of 12.5 kW.

?? The tar trap has been shown to be very effective at removing tars from the raw producer gas. Figure 1 shows a comparison of the tar and particulate levels at various locations in the gas clean up train. This run example also included measurements taken shortly after addition of recycled engine oil, filter fines, and tar trap char. While the particulate levels increased, the tars were not excessive. More importantly, the levels for both tar and particulate at the exit of the filter remained within acceptable values. Samples taken when fresh charcoal is charged to the tar trap show even better tar removal efficiency.

?? Preliminary engine exhaust emissions have also been measured as a function of system load and are shown in figure 2. These results are preliminary and do not reflect detailed investigation of engine timing and other parameters. Future studies will also look at the use of exhaust catalytic converters.

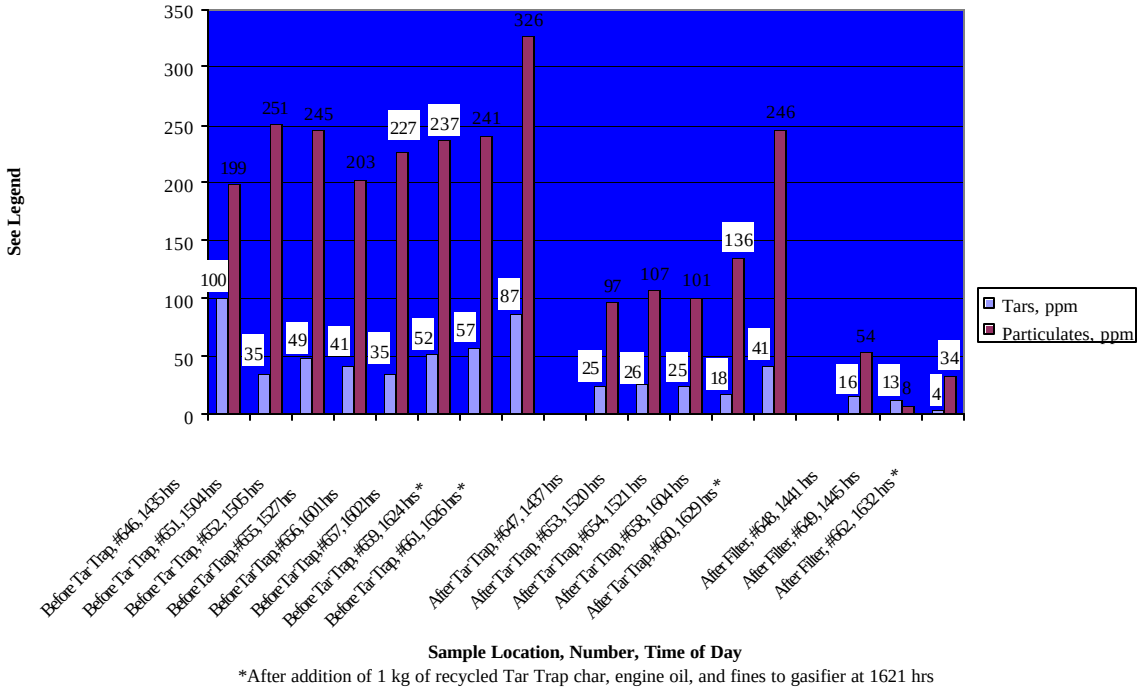

Figure 10. Tars and Particulates in the Producer Gas During Run 606

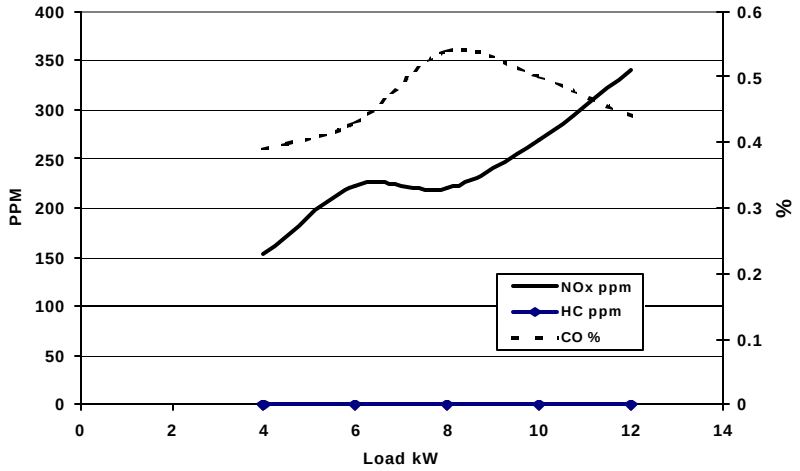

Figure 2. Engine emissions on producer gas

Field operation experience

The SMB was deployed in the village of Aliminos in Aklan Province where it underwent a field endurance run in conjunction with providing power to 120 households. Results from this field trial will also be reported.